

The Tucana dwarf galaxy

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Abstract. Deep CCD photometry for the dwarf galaxy in Tucana is presented. Distance modulus and metallicity are derived, together with an estimate of the age of the galaxy.

1. Introduction

We present deep CCD photometry for the dwarf galaxy in Tucana (l=323, b=-47.4). The observations were made using the high resolution camera SUSY on the 3.5 m NTT of ESO - La Silla in the period from November 4 to November 7 1994. A coated Tektronix tk 1024 X 1024 pixels CCD was used at the Nasmyth focus A, with a scale of 0.12" per pixel. Several frames of a field centered on the main body ($\alpha_{1950}=22^h38^m27.9^s$, $\delta_{1950}=-0.64^040'53''$) of the galaxy were obtained. The observed area corresponds roughly to the 80% of the luminous main body of the galaxy. We also show a preliminary CM diagram of Tucana obtained from HST observations, taken at ESO archive.

2. CM diagram

Fig.1a shows the V vs V-I diagram of the stars obtained after the reduction procedures. Fig.1b shows the same CM diagram obtained with data taken at HST archive. In this last figure is easily seen the signature of an horizontal branch. Red stars apparently describe a well-defined sequence in the CM diagram very similar to the "enlarged RGB" shown by other dwarf spheroidals, like Carina (Smecker-Hane et al. 1994) or Phoenix (Ortolani and Gratton 1988).

Please note that the spread in colour is larger than the one expected on the basis of photometric errors. This could indicate that Tucana is similar, in this respect, to the dwarf spheroidal Carina, and that part of this increase is due to a superimposed AGB population. On the other hand, Tucana shares with the "transition" dwarf galaxy in Phoenix the complete lack of blue bright main

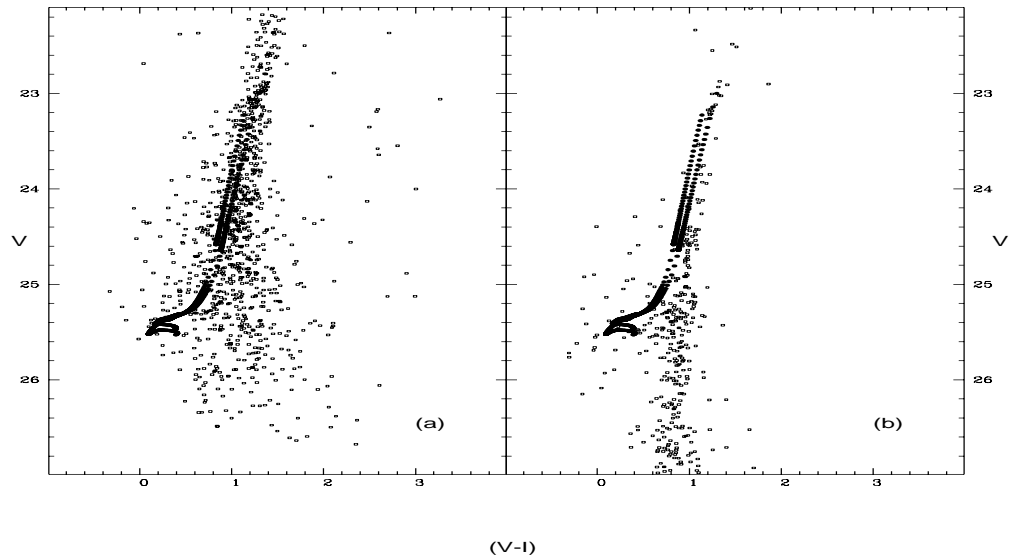


Figure 1. CM diagrams of Tucana: (a) NTT data (b) HST data

sequence (MS) stars, i.e. bright stars with $V-I \simeq 0$. This suggests that *Tucana* is composed mainly of an old stellar population.

3. Distance modulus and metallicity

If we interpret the sequence of Fig.1 as the RGB of an intermediate-old stellar population, we can use the location and the shape of such RGB to estimate the *distance* of the dwarf galaxy in Tucana, through the comparison with the giant branch loci of a sample of galactic globular clusters.

We therefore computed the ridge line of the RGB of Tucana by spline fitting and then, given the negligible reddening of the region of Tucana (see the maps of Burstein and Heiles 1982), we shifted this ridge line vertically to obtain the best match with the sample of globular clusters given by Da Costa and Armandroff (1990). This sample ranges in metallicity from $[Fe/H]=-0.71$ to $[Fe/H]=-2.17$.

Using this procedure, we find that the locus of the Tucana giant-branch appears to overlap on the giant branch loci of NGC6752 ($[Fe/H]=-1.54$) and of M2 ($[Fe/H]=-1.58$), for *distance modulus* $(m-M)_I = 24.72 \pm 0.20$, as shown in Fig.2. This agrees with a previous estimate of $(m-M)_V = 24.8 \pm 0.2$ obtained by Da Costa (1994).

We will therefore assume $[Fe/H]=-1.56 \pm 0.20$ as the metallicity of Tucana. This figure is consistent with the suggestion of Gallagher and Wise (1994), that most dwarf galaxies have mean metallicities near to the peak of metallicities of the halo globular clusters.

Finally, the distance modulus derived above has been nicely confirmed by a different procedure, based on the *use of AGB clump as a standard candle* (Pulone

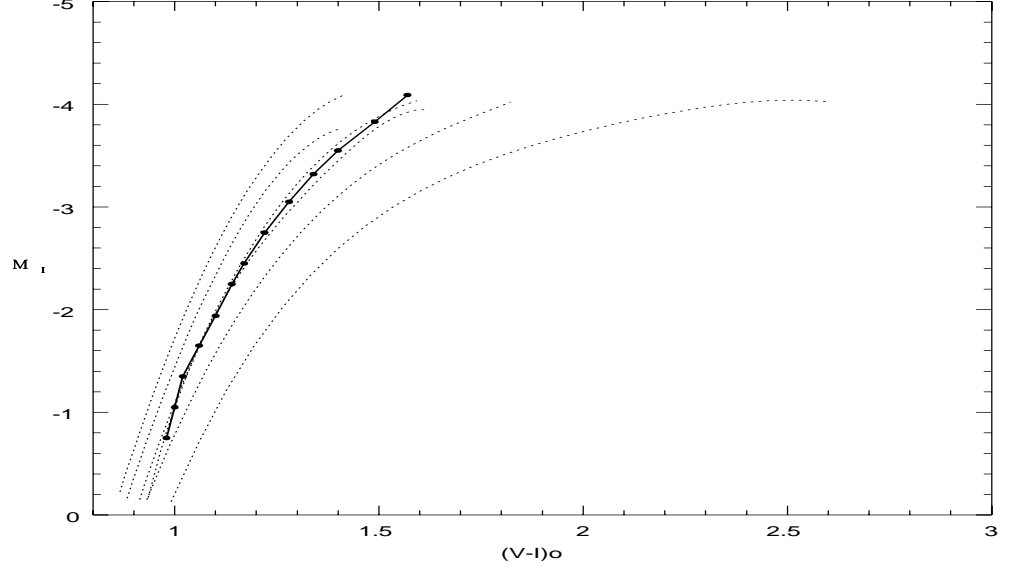


Figure 2. Giant branch loci of six globular cluster (from left, of M15, NGC 6397, M2, NGC 6752, NGC 1851, and 47 Tuc) (from Da Costa and Armandroff 1990) and of Tucana (bold line, NTT data)

1992). In Fig.1 the AGB evolutionary tracks, for two models of $Z=0.0004$ and $Z=0.001$, $Y=0.23$, $M=0.7 M_{\odot}$ (Castellani, Chieffi & Pulone 1991) are also shown, scaled to the CMD of Tucana using the obtained distance modulus.

4. Age estimate

One finds hints that *Tucana is composed, almost exclusively, of an intermediate-old stellar population* ($t \geq 5$ Gyr). This is supported by the lack of blue MS supergiants and red supergiants.

Moreover, the existence of stars of intermediate age and more massive than $1.5 M_{\odot}$ would have been revealed by the presence of a TO structure (in Fig.1) in the region $V \leq 24$, $(V - I) \simeq 0$.

In the light of this conclusion, the bump observed in the luminosity function at $V \simeq 24.3$ mag (see Fig.3) is likely to be interpreted as *the signature of the AGB clump*, due to the slowing down in the evolutionary rate, preceded by a fast evolution at the end of the core He-burning phase. This is well in agreement with the magnitude of the horizontal branch, $V=25.5$, as easily desumed from Fig.1b. We note as the magnitude of ZAHB of the overplotted tracks nicely fits the locus of maximum density of stars in CM diagram.

5. Discussion and summary

We have obtained V, I CCD photometry (NTT, HST) for the dwarf galaxy in Tucana, down to the limit of $V \simeq 27.5$.

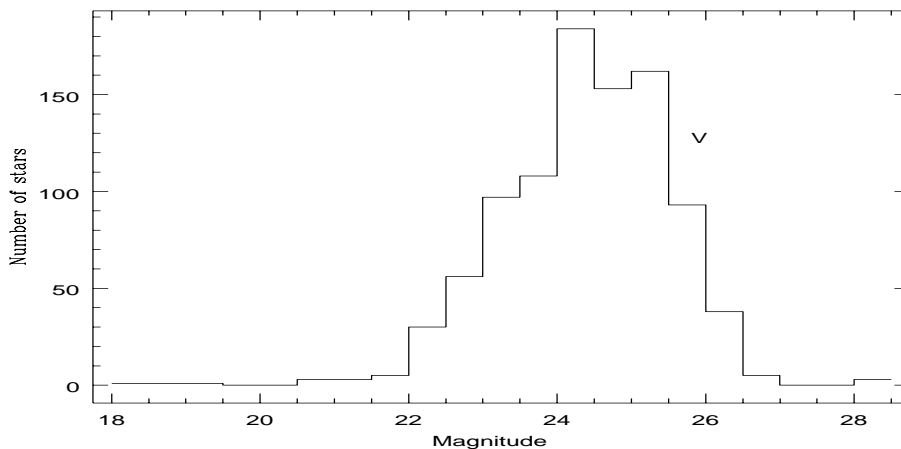


Figure 3. Luminosity function of Tucana (in V band, NTT data)

The **distance modulus** has been derived by different procedures, all converging to a value of $(m - M)_V = 24.7 \pm 0.2$

The **metallicity** have been derived by comparing the RGB locus of Tucana to the ridge-lines of globular clusters of different metallicities, thus obtaining a value of $[Fe/H] \simeq -1.56$.

We suggest that the CM diagrams we obtained allow a straightforward interpretation in terms of *old low-mass stars* in the phase of H-burning in shell (RGB).

In the HST CM diagram (Fig.1b), we also detected *a clear signature of an horizontal branch*.

We did not detect hints of recent and conspicuous episodes of star formation.

The intrinsic dispersion along the RGB has been interpreted as *a dispersion in metallicity of the stars in Tucana*, although the presence of an intermediate population of few AGB stars ($M \simeq 2M_\odot$) cannot be excluded.

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